A Frequency-Based Approach to Long-Term Robotic Mapping

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While mapping of static environments has been widely studied, long-term mapping in non-stationary environments is still an open problem. In this talk, we present a novel approach for long-term representation of populated environments, where many of the observed changes are caused by humans performing their daily activities. We propose to model the environment's dynamics by its frequency spectrum, as a combination of harmonic functions that correspond to periodic processes influencing the environment. Such a representation not only allows representation of environment dynamics over arbitrary timescales with constant memory requirements, but also prediction of future environment states. The proposed approach can be applied to many of the state-of-the-art environment models. In particular, we show that occupancy grids, topological or landmark maps can be easily extended to represent dynamic environments. We present experiments using data collected by a mobile robot patrolling an indoor environment over a period of one month, where frequency-enhanced models were compared to their static counterparts in four scenarios:

– 3D map building [1],
– environment state prediction [2],
– topological localisation [3],
– anomaly detection [2].

In all these cases, the frequency-enhanced models outperformed their static counterparts.

References

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The slides of this talk are available at http://purl.org/robotics/lta2014